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(51) International Patent Classification 6 : G08G 1/0969	A1	(11) International Publication Number: **WO 99/56264** (43) International Publication Date: 4 November 1999 (04.11.99)

(54) Title: METHOD FOR GENERATING AND INTERPRETING A LOCATION REFERENCE INSTANCE WITHIN A DIGITAL MAP

(57) Abstract

For generating a location reference instance within a digital map an object to be referenced is identified. The position of the object is determined by its co–ordinates, the object class to which the object belongs is determined by some or all of its own or related object attributes, and a descriptor comprised of information stored in the attributes of the object or related objects. For transmission purposes the position, the object class and the descriptor is coded in a given format. Within traffic and telematics applications this method is applicable as communication means between a service provider and user.

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5

10   Method for generating and interpreting a location reference
     instance within a digital map

     Background of the invention

15   In the area of traffic and telematics applications the
     exchange of information relating to geographic phenomena
     has been difficult due to the low bandwidth (transmission
     capacity) of transmission media available. This has
     become quite obvious with the development of RDS/TMC
20   (Radio Data System/Traffic Message Channel) services. In
     order to relate any information on a specific part of a
     road network, the information itself and the affected
     location, i.e. intersection, stretch of road, etc., has
     to be communicated. The combination of information and
.25 location, as well as time, is commonly referred to as
     message. Since the available bandwidth for transmission
     is very limited, messages have been coded. The chosen
     coding approach for locations is straight forward: a
     unique code is given to the location. This is an
30   arbitrarily chosen number or identifier which is assigned
     to specific, predefined locations. Several restrictions
     have been accepted with this approach:

• The set of locations which can be referenced is limited
to the set which has been precoded and distributed in a
look-up table.

5   • The code can only be decoded with a look-up table.

• Transmitter and receiver rely on exactly the same look-
up table to decode a location.

10   • The code does usually not reveal any information about
the geographic area being affected.

• Codes have to be maintained centrally, often on a
national level.

15

Pre-defined location codes are very often limited to
serve a specific application, e.g.: traffic information
service.

20   EP 0798540 A1 describes a method for referencing fixed
objects. Nodes within a grid structure are coded. With a
reversible algorithm the nodes can be converted into a
geographical coordinate system.

25   US 5107433 describes a method for inputting starting and
destination points into a navigation system. Data of
street maps comprise a street identification character
and reference point coordinates. In a data storage
inputted data is searched. When there is an agreement the
30   coordinates are taken over for navigation.

Current technology allows to store geographic maps in
computer systems. A geographic map being stored in a
computer system will be referred to as digital map or
digital map databases. The content of a digital map can
be described as objects having a specific location in
space. The location of an object in a digital map is
usually described by means of a co-ordinate system, being
a mathematical model referring to the x and y axis in
space. Additionally such an object carries attributes
describing it in terms of a name and other specific
features. The union of attributes and location are an
object in a digital map.

Digital maps are produced for a wide range of
applications. Standardisation efforts of digital maps
have been limited to data models for specific
applications, such as the GDF [1] data model which is a
CEN standard developed for and used in traffic and
telematics applications. Various organisations produce
digital maps according to the GDF standard. However,
there are some variations with respect to the level of
detail and the content actually being captured. This
results in the inevitable fact that even though digital
maps are according to GDF they can/do slightly differ
depending on the producing organisation.

Most in-vehicle navigation systems use digital maps which
have been captured according to GDF 3.0. In order to use
the above mentioned approach on referring to a specific
location (e.g. an intersection) within the RDS/TMC
service, a digital map producer would have to store the
codes being assigned to any predefined location in

attributes of the corresponding objects. This results in
a dependency of every map producer on the availability of
the look-up table which contains the official code and
the appropriate full description of the object.

Another method of location reference has been developed
by the ERTICO Committee on Location Referencing [2]. The
proposed method is called „Detailed Location Referencing
(DLR) based on Intersection Location (ILOC)".
Intersections in road networks are considered as the
basic elements of reference. An ILOC is defined as an
intersection identified by its centre co-ordinates and
the first 5 characters names or road numbers of three of
the intersecting roads. Every reference made is limited
to the road network, which can be described by a single
ILOC or combinations of ILOCs. Reference to other objects
in a digital map is not possible.

Summary of the Invention

It is an object of the present invention to provide a
method for generating a location reference instance
within a digital map which allows a more efficient and
universal form of referencing. The method of the
invention allows to reference to objects independent of
their positions within a digital map. According to the
steps of claims 1 to 5 an efficient location referencing
is achieved not limited by specific data structures or
applications or predefined codes due to a strict
differentiation between the positions and
descriptors/attributes of an object as well as applying
object-oriented data modelling.

In contrast of the aforementioned patent citations an
object is not only referenced (coded) by a position but
also by an object class and by a descriptor.

5

Brief Description of the Drawings

Figure 1 shows a flow chart of the method for generating
10   a location reference instance,

Figure 2 shows a flow chart of verifying the location
reference instance.

15

Description of the preferred embodiments

According to the invention a spatial object tag (SPOT)
20   approach is used. This spatial object tag (SPOT) approach
on location reference is based on an object-oriented
approach to data modelling. The fundamental construct of
object-orientation is the object which combines data
structure and behaviour in a single entity. For better
25   understanding, the following definitions are given:

        Object: In this context an object refers to a
                   geographic phenomena (e.g. a road, an
                   intersection, etc.) described in terms of a
30   position and attributes. An object can
                   consist of several other objects (e.g. a set
                   of road elements constitutes a road).

Object

class: An object class represents a certain concept

             of reality. Object classes can be

5   hierarchically ordered, i.e. an object class

             may belong to another object class if the

             represented concept is a refinement of the

             other. For example, intersections are an

             object class, further refinement of the

10   object class intersection results in sub-

             classes which may be freeway interchange and

             highway intersection.

Location: A location describes where a single

15   occurrence of an object within a digital map

             is situated. A location is always associated

             with an object. The location of an object can

             be described in either a single position or a

             set of positions.

20

Position: A position is the precise description of

             space in terms of a co-ordinate system. A

             position is at least a pair of co-ordinates.

             A position itself does not relate to

25   anything.

Attribute: An attribute is either a number or text or a

             combination, describing an object,

             independent of its position.

30

             Location

reference: Location reference describes an object in a
digital map in a very condensed form, i.e.
coded, allowing to identify the same object
in another digital map, while taking slight
variations in position and presentation of
the object into account.

The SPOT location reference method relies on the fact,
that an object in a digital map consists of two very
different parts:

• The location of an object expressed as its position
within the digital map.

• Attributes which describe the object regardless of its
location.

Efficient location referencing, not limited by specific
data structures or applications or predefined codes, is
only possible if a strict differentiation between the
position and the attributes of an object is made.
Furthermore a classification of objects according to
concepts applicable within traffic and telematic
applications must be present. The classification needed
for location referencing within traffic and telematic
applications must be made upon doubtless information of
reality.

When comparing a digital map from vendor A with one from
vendor B, even if they are built according to the same
principle (e.g. GDF) differences for precisely the same
object can be noticed:

An object referring to the same geographic phenomena in
reality may have different co-ordinates in different
maps. The location of an object, i.e. its position, is
described with co-ordinates. These co-ordinates are
assigned to the object in the digitisation process.
Digitisation can be done on the basis of a wide range of
different sources such as satellite images, aerial
photographs, topographic paper maps or cadastral paper
maps. Since the resolution, i.e. the level of detail, of
certain geographic phenomena differs with regard to the
used source, the same object may be located at slightly
different positions depending on the used source.

An object referring to the same geographic phenomena in
reality may have different representations (different
data models) in different digital maps. Even the GDF data
model allows for variations on the representation of
objects.

By means of location reference one has to describe a
geographic phenomena represented as an object in a
digital map and check/present the object representing the
same geographic phenomena in a different digital map.
This can be done in two different ways:

An object can be referred to by its name (e.g. street
name). This may lead to a rather large set of objects
satisfying the requested name. Significant additional
effort is necessary in order to find exactly the one
object in question. It may even be possible that the
object being searched for can not be found due to missing

or different relations within the queried digital map,
even though it does exist within that digital map.
Alternatively some sort of authority would have to assign
a specific name or identifier to all objects that shall
be referred. This approach is used for the generation of
RDS-TMC location codes.

An object can be referred to by its position, i.e. the
co-ordinates of the used digital map. Most likely this
object will have different co-ordinates in another
digital map, due to the digitisation process. A variation
of this method would assign the position of an object to
a co-ordinate of a fixed resolution. An object is
assigned to the nearest co-ordinate of a fixed resolution
co-ordinate system (e.g. 100m precise co-ordinate
system). In case two objects would refer to the same co-
ordinate, one is being shifted to another near by co-
ordinate. This requires pre-assigning co-ordinates to
objects (Reference to EP 0 798 540 A1 possible).

The existence of an object in a digital map depends on
the capturing rules being applied. The accuracy of an
object location depends on the capturing process. This
implies that if a location shall be referenced it should
be done by the position of the object instead of
attributes of the object. It must be assumed that the
transmitter of a location reference does not know,
whether the receiver has the object in question or how
exactly the object has to be referenced by means of
attributes. Using the position of an object and allowing
for a search area around the position in the receiving
digital map grants an unambiguous solution.

The following prerequisites have to be considered. The
object exists in reality. The object is either captured
in a digital map or not. Real world information

5   associated with an object is either captured as attribute
of the object or attributes of sub-objects. This real
world information describes certain features and/or
functions of the object. Parts of this information are
sufficient to assign the object to an object class which

10   represents some sort of concept suitable for traffic and
telematic applications. The area within which the object
in the receiving digital map should be located is known
(by the co-ordinates of the object within the sending
digital map). Of course, the used co-ordinate system must

15   be agreed upon between sender and receiver. In some cases
more than one object of a certain object class maybe
located within the search area of the receiving digital
map. Therefore, some additional information must be
supplied to make the object unique within the possible

20   set of objects of this class. This part of information,
is called descriptor.

With regard to the location reference as defined before
the following can be concluded:

25

• An object is either in the digital map or not.

• Referencing an object by its attributes can become
difficult considering the fact, that variations of the

30   data model and/or certain attribute values are possible.

• The position of an object may vary between digital maps, due to the capturing process. Therefore, location reference must support a spatial range query based on a given position in order to determine the existence and allow the presentation of the requested object. Actually the method for location reference according to the invention is based on the following proposition:

An Object Instance, i.e. a single object:
- belongs to exactly one object class
- has a position within a given digital map (which is its location)
- has attributes of its own or attributes of its sub-objects, allowing for classification according to object classes suitable for traffic and telematic applications.
- some or all attributes of an object refer to real world information.

The process of SPOT location reference between digital maps can be divided into three steps:

Generate the location reference instance, i.e. create a code consisting of a positional part, a classification part, and a descriptive part, for some geographic phenomena stored as an object in a digital map.
(in order to compact the location reference)

Transmit the location reference instance, i.e. the above mentioned code
(via any transmission media)

Verify the location reference instance, i.e. decode the
transmitted code and interpret its contents in order to
verify the presence of an object representing the same
geographic phenomena as intended by the creator of the

5   location reference instance.
(Find and present the object being referred to)

Verifying a location reference is a combination of
retrieval methods of objects in digital maps. In order to

10   determine the same geographic phenomena in a digital map
of another map producer, the following components of a
location reference instance will be generated,
transmitted and verified:

15   POSITION: is the spatial description of a geographic
phenomena stored in an object in terms of co-ordinates of
an agreed upon co-ordinate system (e.g. WGS 84). The
spatial description maybe reduced to a single co-
ordinate, since the accompanying object class reveals the

20   actual geometric representation, i.e. point, line, area.
The position will be used to determine the centre of a
search area in the verifying digital map.

OBJECT CLASS: is the representation of a group of

25   objects, all satisfying a certain concept
applicable within traffic and telematic
applications. Each object class will be
coded for efficient transmission of a
location reference instance. The definition

30   of an object class and its code must be
agreed upon between sender and receiver. It
is advisable to define object classes which

are based on doubtless information of
reality (e.g. an Autobahn in Germany is
determined by the officially assigned code
"A" followed by a number). An object class

5   is the abstract generalisation of objects
regardless of the data structure or data
model used.

DESCRIPTOR: is part of common information of an object

10   (e.g. a street name). The common
information to be used in a location
reference instance is determined by the
object class. For efficient transmission of
the location reference instance, the

15   descriptor may either be coded or represent
only a small portion of the common
information.

The SPOT location reference method is now further

20   described using several steps.

Generation of a location reference instance:

In digital map A: This is the digital map being used to

25   create the location reference instance of an object x
(see flow chart according to Figure 1):

• Identify the object x which shall be referenced
• Determine the object class of object x

30   • Determine the position of the object x by its
coordinates
•Identify the descriptor of the object x

• Code the position, the object class and the descriptor
  into an agreed upon physical format.

Transmission of a location reference instance:

5

• Transmit this code.

Verify the location reference instance:

10   In digital map B: This is the digital map being used to
          present the location which is being referred to (see flow
          chart according to Figure 2):

          •   Decode into position, the object class and the
15   descriptor from the physical format into the system
              format

          • Determine the centre of a search area by the decoded
            co-ordinates

20

          • Search the digital map for objects representing the
            geographic phenomena being coded in the location
            reference instance:
            Create the search area determined by the object class
25   with a centre at the decoded position of the location
              reference instance. The digital map B is now split into
              two parts, the complete digital map and a small area
              within, being the search area. In the next steps only
              the content of the search area is of interest.
30   In most cases several objects of various object classes
              will be present in the search area. Determine for each
              object in the search area whether it belongs to the

object class of the location reference instance or not.
Those objects which are not part of the object class of
the location reference instance are being neglected.
All objects which are within the search area are

5   collected. If more than one object of the object class
of the location reference instance has been found,
compare each of these objects with the descriptor of
the location reference instance (verification the
decoded/given descriptor with attributes or parts

10   thereof of the collected objects). The object that
matches the descriptor represents the geographical
phenomena being referenced within digital map A in the
receiving digital map B.

15   Within traffic and telematics applications the method
according to the invention will be applicable as
communication means between service provider and user. On
behalf of the receiver a navigation system is perfectly
well suited to make use of the shown method. Additional

20   databases or look-up tables to keep location codes become
obsolete. Digital map producers who provide maps for
navigation systems do no longer need to store predefined
codes to enable traffic and telematic services to refer
to a certain object within the digital map of the

25   navigation system. In general the described method can be
implemented whenever location referencing of objects
between similar digital maps is needed. The method allows
to transfer the reference information of an object
through low bandwidth transmission media.

30

References:

[1] ENV ISO 14825 "Geographic Data File (GDF) 3.0";
Digital Map Database Standard (data model, data
dictionary, exchange format), CEN/TC278; 12 October 1995.

[2] Ralf Duckeck, Volker Hiestermann, Hugh Milton, Kees
Wevers: "Rules for defining and referencing an
Intersection Location (ILOC); Detailed Location
Referencing (DLR) for ITS based on ILOCs's; draft report
of ERTICO Committee on Location Referencing, Version 0.8;
Brussels, Belgium; 14 April 1998.

5

10   Claims

        1. Method for generating a location reference instance
        within a digital map comprising the steps of:
        - identifying an object to be referenced
15   - determining the position of the object by its co-
          ordinates within the map,
        - determining the object class of the object,
        - identifying a descriptor of the object from common
          information stored in attributes, to verify the actual
20   object in case of more than one object satisfies a
          spatial range criteria and belongs to the same object
          class,
        - coding the position of the object, the object class and
          the descriptor in a given format.

25

        2. Method according to claim 1 by transmitting the generated
        location reference in the given format via a given
        transmission media.

30   3. Method according to claims 1 or 2 further comprising the
        steps of:
        - decoding into position, the object class and the
          descriptor of the location reference data into a given
          system format, which can be different from the given
35   format,

- creating a search area dependent or independent of the
  decoded object class with a centre at the co-ordinates of
  the decoded position.
- collecting all objects which are within the search area
  and within the decoded object class,
- verifying the decoded/given descriptor with attributes or
  parts thereof of the collected objects

4. Method according to at least one of claims 1 and 3
further comprising the steps of:
- defining object classes which are suitable for traffic
  and telematic applications and based on doubtless
  information of reality.
- assigning objects to object classes suitable for traffic
  and telematic applications and based on doubtless
  information of reality from all or some attributes of an
  object or related objects.

5. Method according to at least one of claims 1 to 4 further
comprising the steps of:
- pre-processing a digital map by explicitly identifying
  object classes suitable for traffic and/or telematic
  applications and being based on doubtless information of
  reality from all or some attributes of an object or
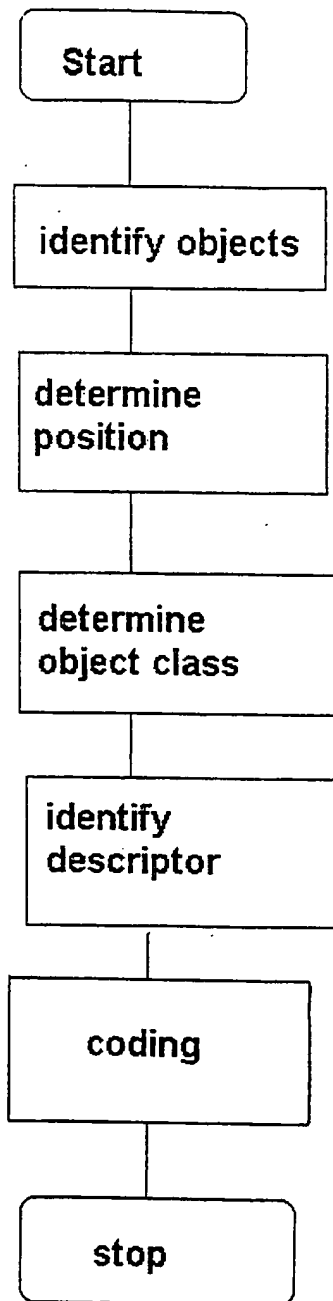 related objects to an attribute of such a classified
  object.

FIG. 1

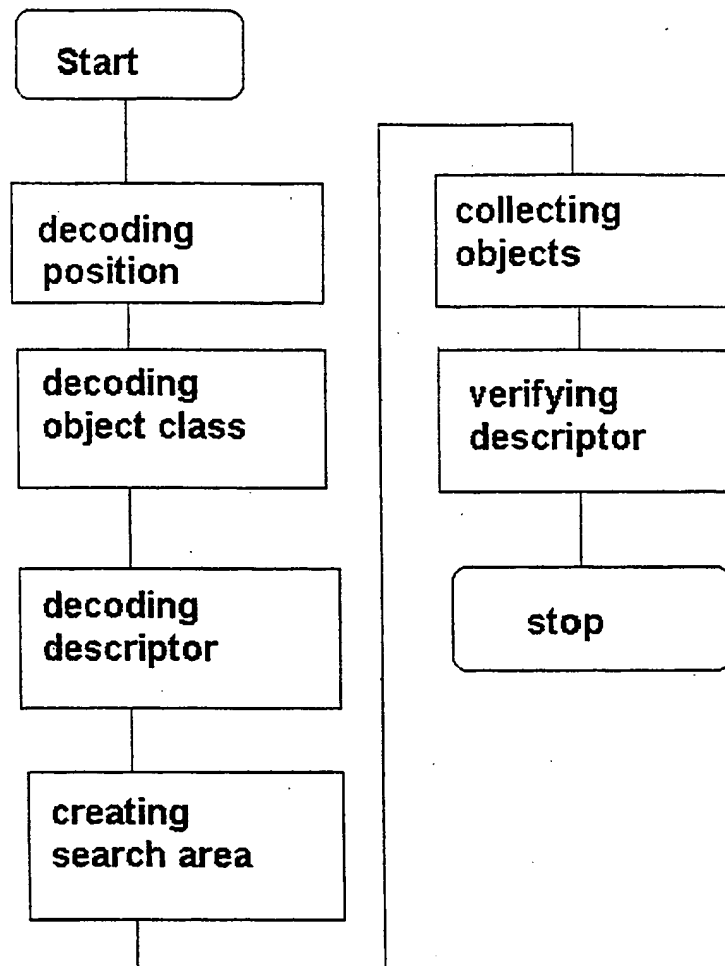FIG. 2

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6   G08G1/0969

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6   G08G   G01C   G09B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched·

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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7 September 1999	15/09/1999

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INTERNATIONAL SEARCH REPORT

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